TABLE 1

Experimental Results and Model Predictions for both Flat and Featured Coupons

	Featureless Coupon Kinetic Level = 1x (baseline as predicted based on flat or featureless channel or coupon)		Feature Coupon Kinetic Level = 2x over baseline	
Temperature (° C.)	Experiment (%)	Prediction (%)	Experiment (%)	Prediction (%)
675	9.9	11.7	20.5	18.7
750	35.1	35.6	48.8	45.1
800	58.0	55.9	70.8	62.6
850	71.8	70.9	81.6	75.4

[0337] These results show that the use of surface features further enables a reduction in external mass transport resistance found with chemical reactions. A catalyst would have to be at least 2 times as active if disposed on a flat wall than if disposed on a surface feature channel. This result is due in part to the increase in surface area (roughly 60%) and in part to a reduction in external mass transport resistance resulting from the elimination of laminar parabolic fluid profile and the induction of convection to bring reactants from the bulk flow path to the catalyst coated wall.

Example 14

2 Sided Surface Features for the Enhancement of Fuel Lean Combustion of Methane and Carbon Monoxide

[0338] A platinum rhenium catalyst was applied as a slurry to two types coupons, one with surface features and one without surface features, and these were tested to determine enhancement produced by the addition of surface features in the fuel lean combustion (excess oxygen) of CO and methane. Results indicated greater conversion of both CO and methane over the surface feature coupon. Increased pressure drop observed over the surface feature coupons (1.5 to 1.8×) indicated that the surface features were affecting the flow field. Although both coupons experienced deactivation the surface feature coupon obtained steady conversion with time-on-steam duration of the test. Conversion of methane appeared to be limited by reaction rate for both the flat and surface feature coupons however conversions of CO appeared limited by mass transfer. In the case of CO combustion inclusion of surface features reduced the initial outlet CO by a factor of 15× (compared to a increase in surface area available for catalysis of 2.2×). Average enhancement for CO combustion after the burn in period was 4.1×. This boost in activity is above that expected based on the surface area effect and can be attributed to mixing of the streamlines by the surface features (and there by maximizing the concentration of reacting species close to the catalytic surface) as well as by increasing the effective residence time of any fluid volume by causing it to turn and take a longer path through the reactor (longer than that which would occur in strictly laminar flow).

[0339] The surface feature coupon had approximately 2.2 times the surface area of the flat coupon and as the catalyst was applied such as to provide similar loading rates (mass per unit area) it would be expected that an effect in this order would be seen however the reduction of CO over the surface feature coupon reflect on average an increase in reaction rate 4.1× greater than the flat or featureless coupon. Thus, for CO combustion, the surface features provide enhancement over a flat coupon much in excess of that expected by the increased mass of catalyst. This enhancement is largely due to the mixing of the flow induced by the features. This mixing maintains high reactive species concentrations close the catalyst covered surface. In addition to this mixing effect fluid elements tend to be moved in longer pathways through the reactor than they would otherwise experience in laminar flow. This has the effect of increasing the average residence time for any given fluid element.

Example 15

"See-Through" Surface Features for the Enhancement of Mixing and Heat Transfer

[0340] A "See-Through" surface feature is one, of any shape that passes continuously through a wall such that a connection is made to an adjacent channel (i.e., the surface channel connects a bulk flow channel to an adjacent space or channel). Multiple see-through features may be aligned on top of each other to increase the depth of a surface feature. Even in the absence of a solid surface at the bottom of the feature they will still act to turn the flow in the main channel as fluid shears against fluid in the adjacent channel. "See-Through" features are especially useful in situations in which single sided mixing of a relatively large gap is required.

[0341] In a second application the features can be used to stir an incompressible flow that is required to maintain solids in suspension. A benefit of the "See Through" features is that, especially when the channels are deployed vertically, suspended particles cannot accumulate at the 'bottom' of the features but the particles find that, when they become disengaged that they fall back into streamlines that re-suspend them. In another application solid particles are suspended in a compressible flow and are maintained in suspension via "See Through" features and in yet another application liquid droplets are suspended in a compressible flow and maintained in suspension. Similar effects can be obtained with two immiscible (or partially immiscible fluids).

[0342] In a third application catalyst can be retained in a surface feature and the effectiveness of the coating increased by allowing diffusion of reactants and products into the coating from both sides (as opposed to coatings in a pocket type surface feature in which diffusion is from one side only.

[0343] In a fourth application two immiscible fluids are flowing on either side of the see-through feature containing wall, for example air saturated with water and water saturated with air, are flowing co-currently on either side of the feature. Particles suspended in the air stream are brought into the features by the mixing of the air stream by the features and are brought in contact with the water. The particles then become suspended in the water and are scrubbed from the gas phase. Alternatively, a gas and liquid (or liquid and liquid) may not be saturated and the contacting at the interface leads to the production of saturated streams.